<u>IN THE DRAWINGS:</u>

Figure 1 has been amended as shown on the replacement sheet attached hereto.

REMARKS

A typographical error was noted in the specification at page 7 wherein the components at the output of the reception channel 8 of the radio frequency system 22 were stated to be supplied to an analog-to-digital converter, but the designation DAC was used instead of ADC. This location in the specification has been corrected, as has the corresponding designation in Figure 1. In addition, in Figure 1 professionally lettered legends have been provided instead of the original handwritten legends.

In the Office Action dated April 26, 2005, claims 1-3, 5-10 and 12-14 were rejected under 35 U.S.C. §102(b) as being anticipated by Krieg et al. Claims 4 and 11 were rejected under 35 U.S.C. §103(a) as being unpatentable over Krieg et al. in view of Heid.

Applicants and their counsel have carefully reviewed the teachings of the Krieg et al. and Heid references, but believe the claims as originally filed are patentable over the disclosures and teachings of those references. The above rejections therefore are respectfully traversed, and reconsideration is requested in view of the following arguments in support of patentability.

At the bottom of page 2 of the Office Action, the Examiner made the unsubstantiated statement that the Krieg et al. reference discloses a sequence controller 20 that operates the RF system and the gradient coil system in the Krieg et al. reference "to generate FISP (Steady-state) with flip angle less than 90 degree." The term FISP is not a "condition" that is generated, but is an acronym for a pulse sequence (Fast Imaging with Steady Precession) that has inherent characteristics known to those of ordinary skill in the field of magnetic resonance imaging that

differentiate a FISP sequence from other types of known pulse sequences used for imaging. From the Examiner's statement, it is not clear whether the Examiner considers any pulse sequence that achieves a steady-state condition to be a FISP sequence, or the equivalent of a FISP sequence. If this is the position of the Examiner, the Examiner is requested to substantiate this position with technical evidence, because Applicant submits it is not consistent with the meaning of a FISP pulse sequence that is conventionally understood by those of ordinary skill in the field of magnetic resonance imaging.

As an example of a FISP sequence, Applicant provided, in Figure 2, an explanation of the true-FISP pulse sequence. No pulse sequence resembling such a sequence is disclosed or suggested in the Krieg et al. reference.

This is understandable, because the object of the method and apparatus disclosed in the Krieg et al. reference, as explained at column 2, lines 28-57, has nothing to do with exciting first and second spin ensembles, and receiving the respective steady-state signals associated therewith, as set forth in independent claims 1 and 8 of the present application. Instead, the purpose of the method and apparatus disclosed in the Krieg et al. reference is to avoid artifacts that are generated by superimposition of the acquired magnetic resonance signals, even in the case of a main magnetic field that exhibits inhomogeneities, and while using a short measuring (signal acquisition) time.

For this purpose, the sequences disclosed in the Krieg et al. reference include a first RF pulse and a second RF pulse, both of which serve a dual purpose, namely serving as excitation pulses to excite nuclear spins, as well as serving as refocusing pulses that re-phase the nuclear spins. The Krieg et al. method and apparatus are

intended as an improvement over the prior art pulse sequence shown in Figure 6 of Krieg et al., wherein the time intervals between all of the pulses (first and second RF pulses and readout gradient pulses) are equal. This causes all MR signals (from the excitation or refocusing of preceding sequences) to occur only within one readout time, after both RF pulses. Therefore, the aforementioned problem arises that each measured signal represents the superimposition of a number of MR signals, which leads to severe banding (stripe) artifacts.

To overcome this problem, in the method and apparatus disclosed in the Krieg et al. reference, the MR signals from the second RF pulse of the $(n-1)^{th}$ repetition and from the first RF pulse of the immediately following n^{th} repetition do not superimpose. This is accomplished by making the time duration τ_3 (the waiting time between the signal acquisition and the next RF excitation pulse) unequal to the time duration τ_1 and τ_2 (according to Figure 2, Figure 7 or Figure 8 of Krieg et al.), thereby allowing for multiple acquisition times and thereby avoiding the aforementioned superimposition problem.

Therefore, aside from failing to disclose a basic FISP sequence, the Krieg et al. reference clearly does not disclose a FISP sequence with completely balanced gradient pulse trains within each repetition time, nor does any pulse sequence in the Krieg et al. reference include RF excitation pulses with respective flip angles that are less than or equal to 90° and that alternate in sine from excitation pulse-to-excitation pulse (thus defining a true-FISP pulse sequence as illustrated in Figure 2), and as set forth in claim 1. Moreover, the Krieg et al. reference does not disclose a sequence that excites spins in a first spin ensemble and a second spin ensemble having respective steady-state signals associated therewith. Since the generation of

such steady-state signals from respective spin ensembles is nowhere disclosed in the Krieg et al. reference, there cannot be any disclosure in the Krieg et al. reference that such steady-state signals will either have the same or opposite signal polarities, as also set forth in claim 1.

In the Krieg et al. reference, the separation of steady-state signals is *not* associated in any way with different spin ensembles, as explained above.

In the method and apparatus set forth in claims 1 and 8 of the present application, the separate of steady-state signals from respective spin ensembles is achieved by the use of RF excitation pulses that are separated by respective repetition times, with each repetition time being incremented, relative to an immediately preceding repetition time, by a selected phase angle increment. The Krieg et al. reference does provide a discussion of a phase increment, but the phase increment discussed and used in the Krieg et al. method and apparatus having nothing to do with the aforementioned phase increment of the present invention. In claims 1 and 8, the phase increment results in a *system* rotation frequency between the respective frequencies of the different ensembles, such as between the water-spin frequency and the fat-spin frequency. Depending on the acquisition time, the steady-state signals of both spin ensembles thereby can be acquired with the same signal polarity or with opposite signal polarity.

The phase increment discussed in the Krieg et al. reference at column 6, line 52, and shown in Figure 8, is not the same as this phase increment that is used in the context of the present invention. The incrementation by θ that is described at column 6, lines 48-60 of Krieg et al., is in the context of a discussion of the well-known prior art technique known as "radio frequency spoiling" or "phase spoiling."

The purpose of this spoiling technique is to destroy (dismantle) any remaining transverse magnetization by changing the excitation angle (excitation direction) of the RF pulse. The fact that this has nothing to do with the phase incrementation in the present invention should be clear from the next paragraph in the Krieg et al. reference, beginning at column 6, line 61, that describes a further possibility for achieving the same result (incoherent steady-state condition) is to insert a strong gradient pulse before each sequence.

In the Krieg et al. reference, an example of changing the excitation angle is given as being a rotation of 51° relative to the previous excitation pulse, in the context of the aforementioned "radio frequency spoiling." By contrast, the increment set forth in claims 1 and 8 results in a linear phase development over the entire pulse sequence, which does not produce any spoiling effect, but instead enables data acquisition wherein signals from different spin ensembles, such as water and fat signals, to be clearly separated by splitting the magnetization of the respective spin ensemble.

The Krieg et al. reference, therefore, does not disclose all of the elements of either of independent claims 1 and 8, and thus does not anticipate either of those claims, or any of the claims depending therefrom.

Moreover, in view of the complete lack of any disclosure whatsoever in the Krieg et al. reference regarding the use of any type of FISP sequence, modification of the method or apparatus disclosed in the Krieg et al. reference in accordance with the teachings of Heid would still not result in a method or an apparatus as set forth in claims 4 and 11, which respectively embody the subject matter of independent claims 1 and 8 therein. Therefore, neither of claims 4 nor 11 would have been

obvious to a person of ordinary skill in the field of magnetic resonance imaging under the provisions of 35 U.S.C. §103(a) based on the teachings of Krieg et al. and Heid.

All claims of the application are therefore submitted to be in condition for allowance, and early reconsideration of the application is respectfully requested.

Submitted by,

Steven H. Noll (Reg. 28,982)

SCHIFF, HARDIN LLP
CUSTOMER NO. 26574
Patent Department
6600 Sears Tower
233 South Wacker Drive
Chicago, Illinois 60606
Telephone: 312/258-5790
Attorneys for Applicants.

CH1\ 4301493.1